

Determining η_{Earth} : The case for late M-dwarfs

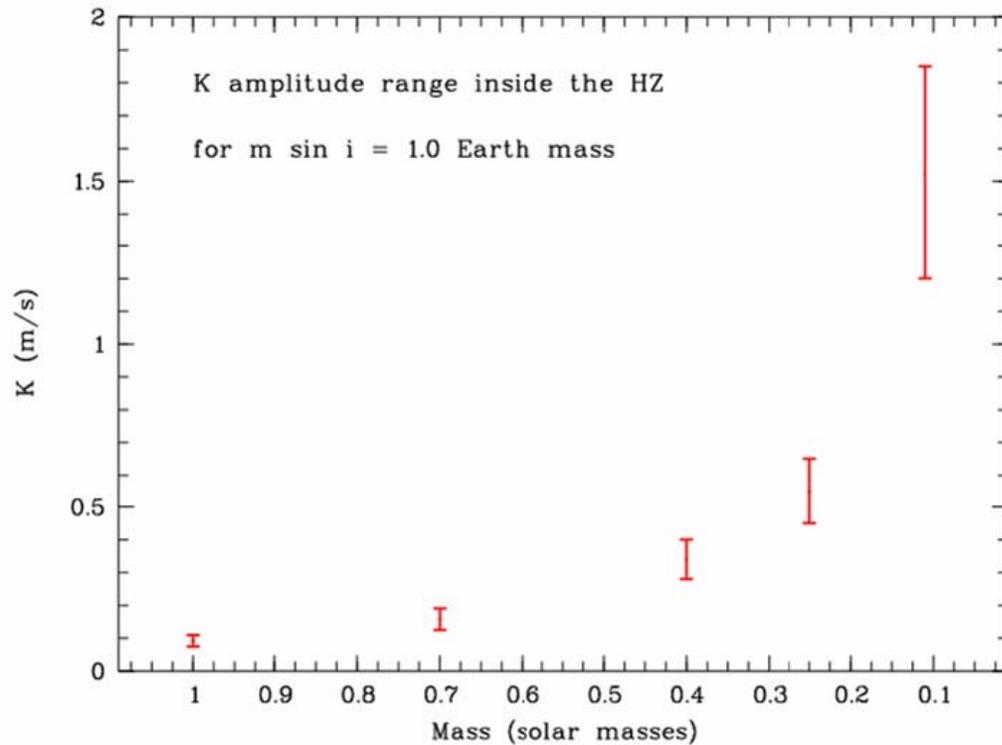
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The case for late M dwarfs:



For stars with masses $< 0.2 M_{\text{Sun}}$ even terrestrial planets inside the classic habitable zone (HZ) have detectable radial velocity amplitudes

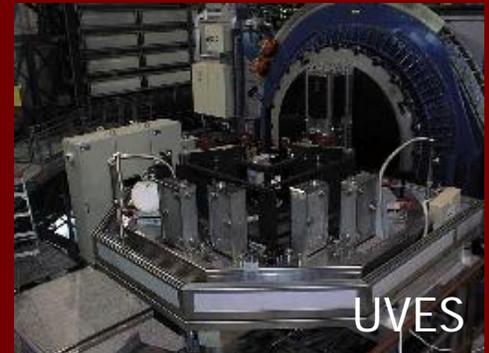
pilot study:

21 M dwarfs (M0 – M5V)

mass range = $0.5 - 0.12 M_{\text{Sun}}$

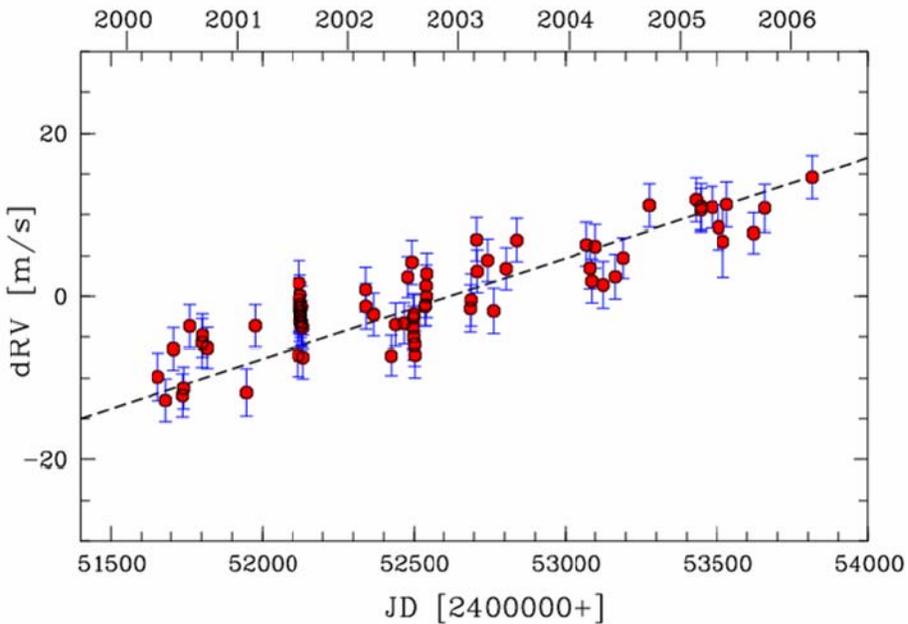
$V = 8.14 - 11.48$ mag

UVES: $R = 110,000 + I_2$ cell



GJ 699 = Barnard's star [M4V]

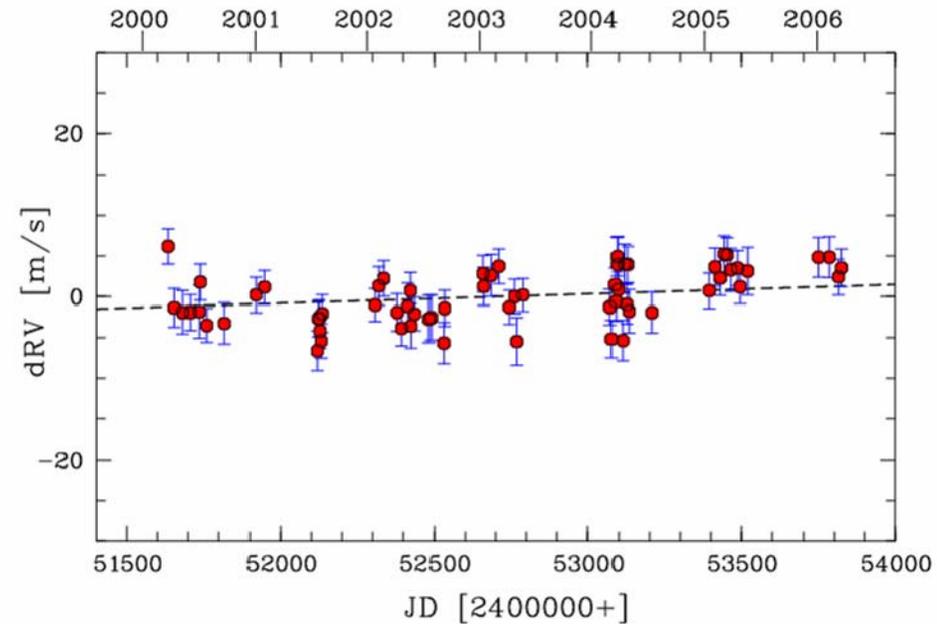
$V = 9.54$ $d = 1.82$ pc



secular acceleration:
4.499 m/s/yr

GJ 551 = Proxima Centauri [M5V]

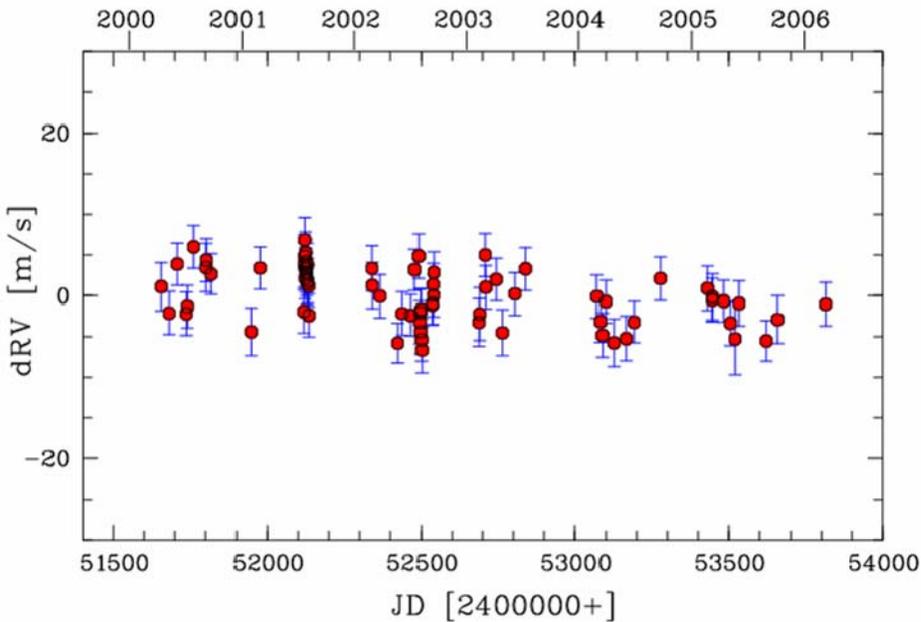
$V = 11.05$ $d = 1.29$ pc



secular acceleration:
0.45 m/s/yr

GJ 699 = Barnard's star [M4V]

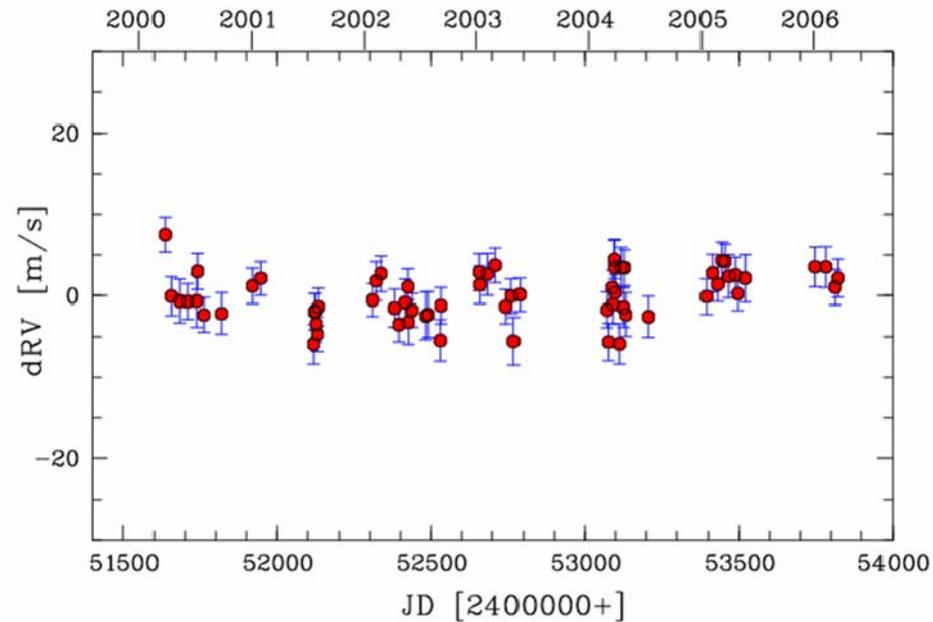
$V = 9.54$ $d = 1.82$ pc



$$\sigma_{\text{dRV}} = 3.38 \text{ m/s}$$
$$N = 72$$

GJ 551 = Proxima Centauri [M5V]

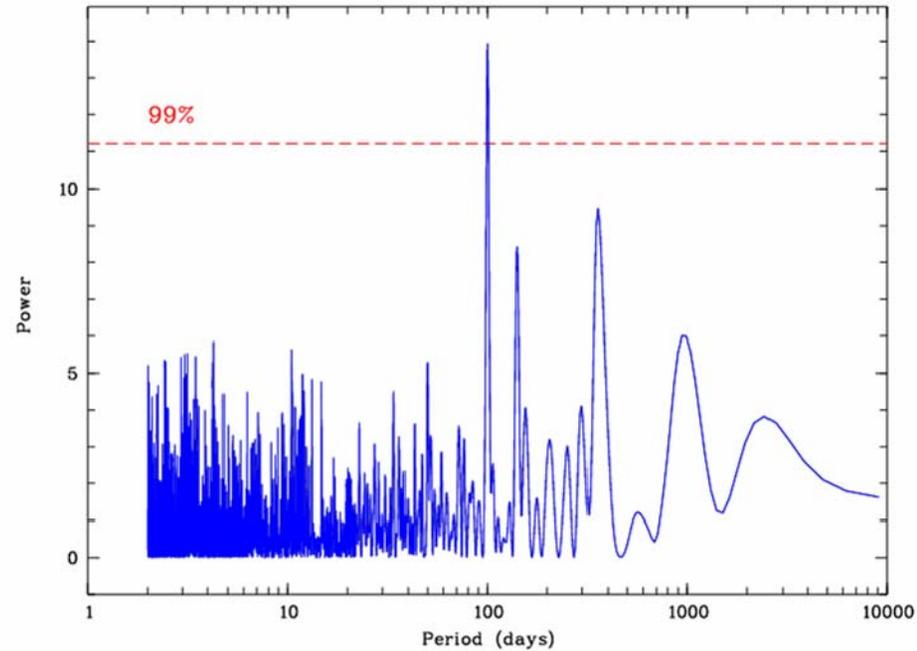
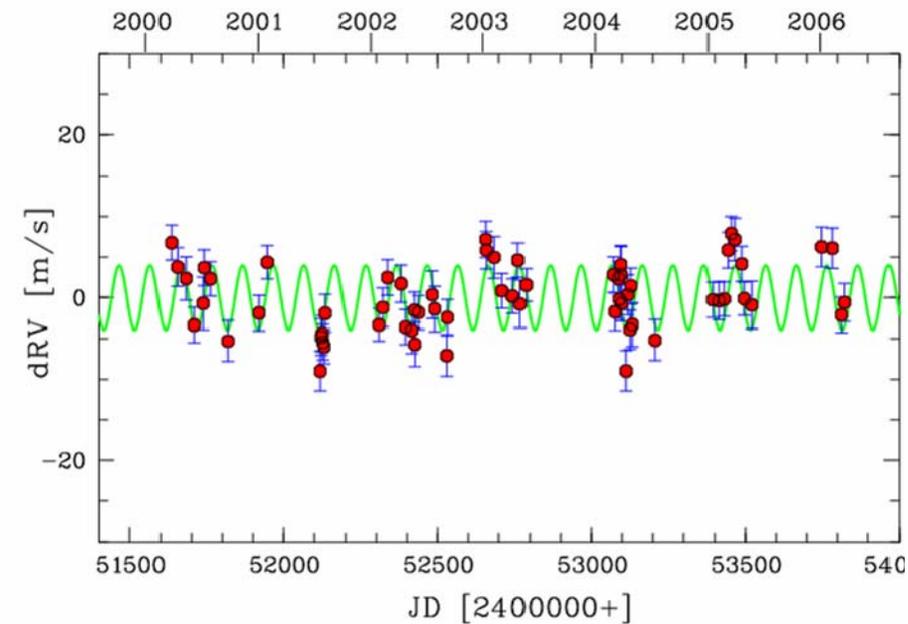
$V = 11.05$ $d = 1.29$ pc



$$\sigma_{\text{dRV}} = 2.95 \text{ m/s}$$
$$N = 63$$

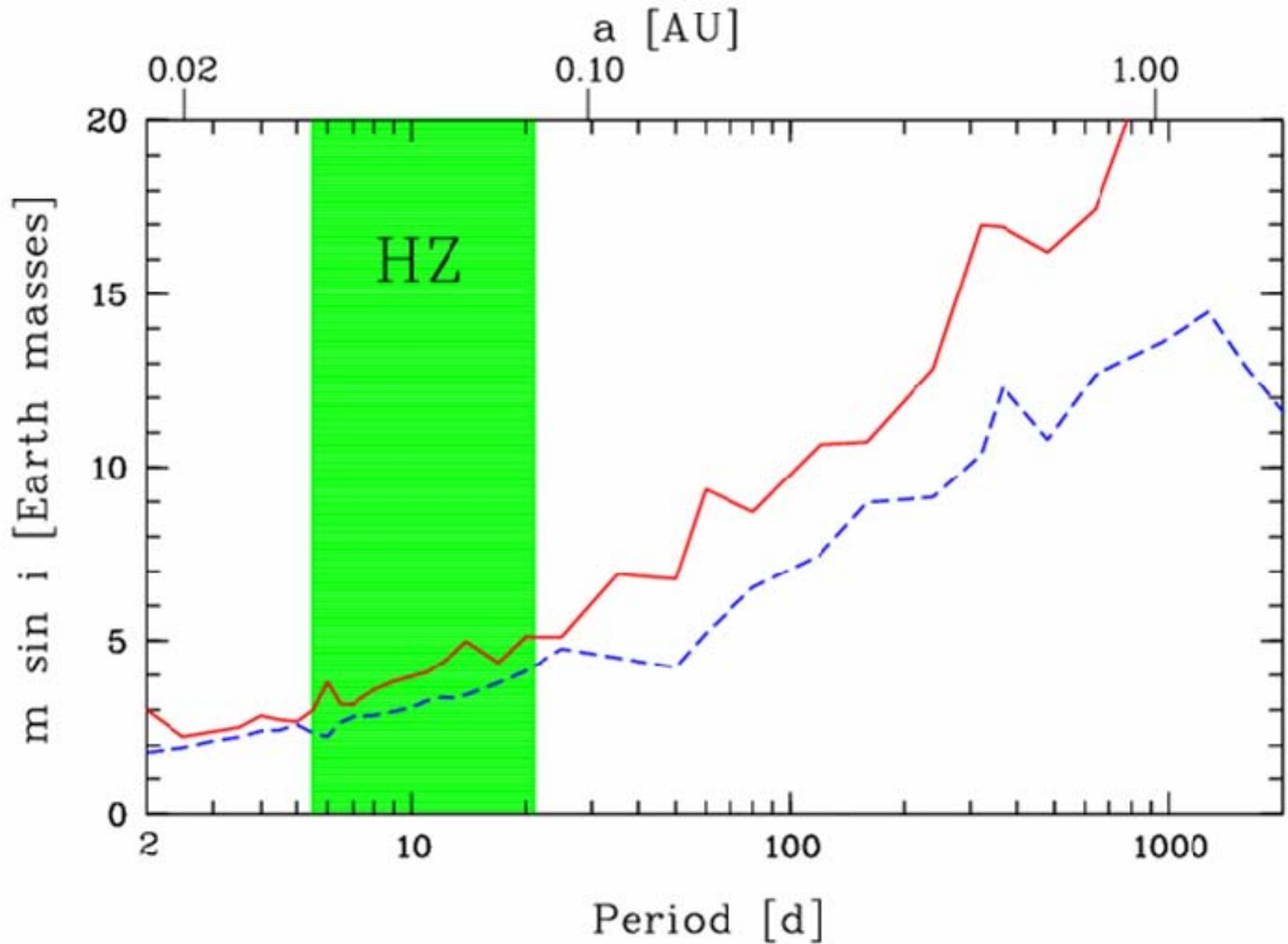
Determination of companion mass limits:

$P = 100$ days ; $K = 4.0$ m/s ; phase = $2/16$
 $e = 0$; $m \sin i = 7.1 M_{\text{Earth}}$

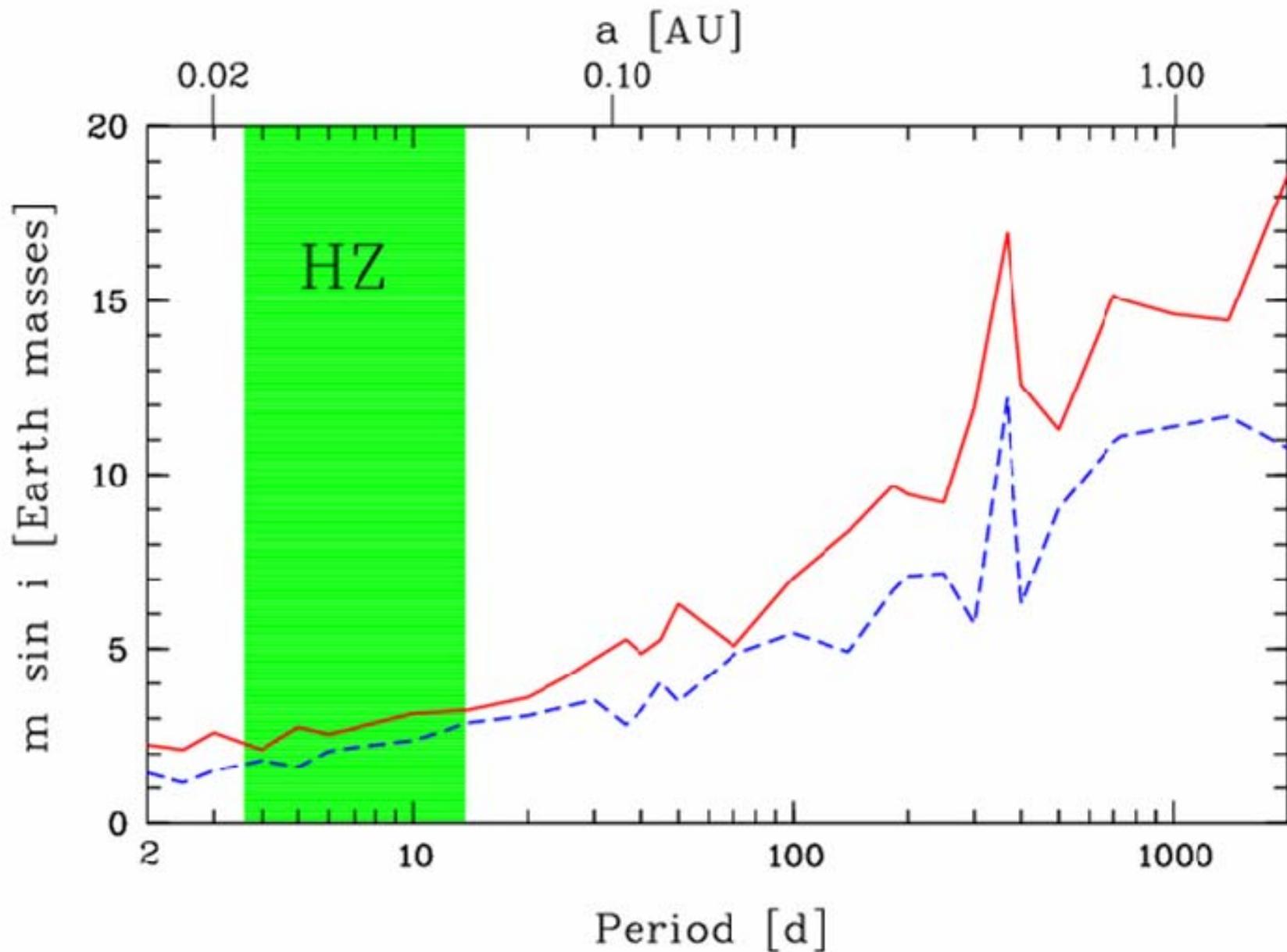


If test signal is recovered at all phase angles with $> 99\%$ significance \Rightarrow limit set for planet mass ($m \sin i$) at period P

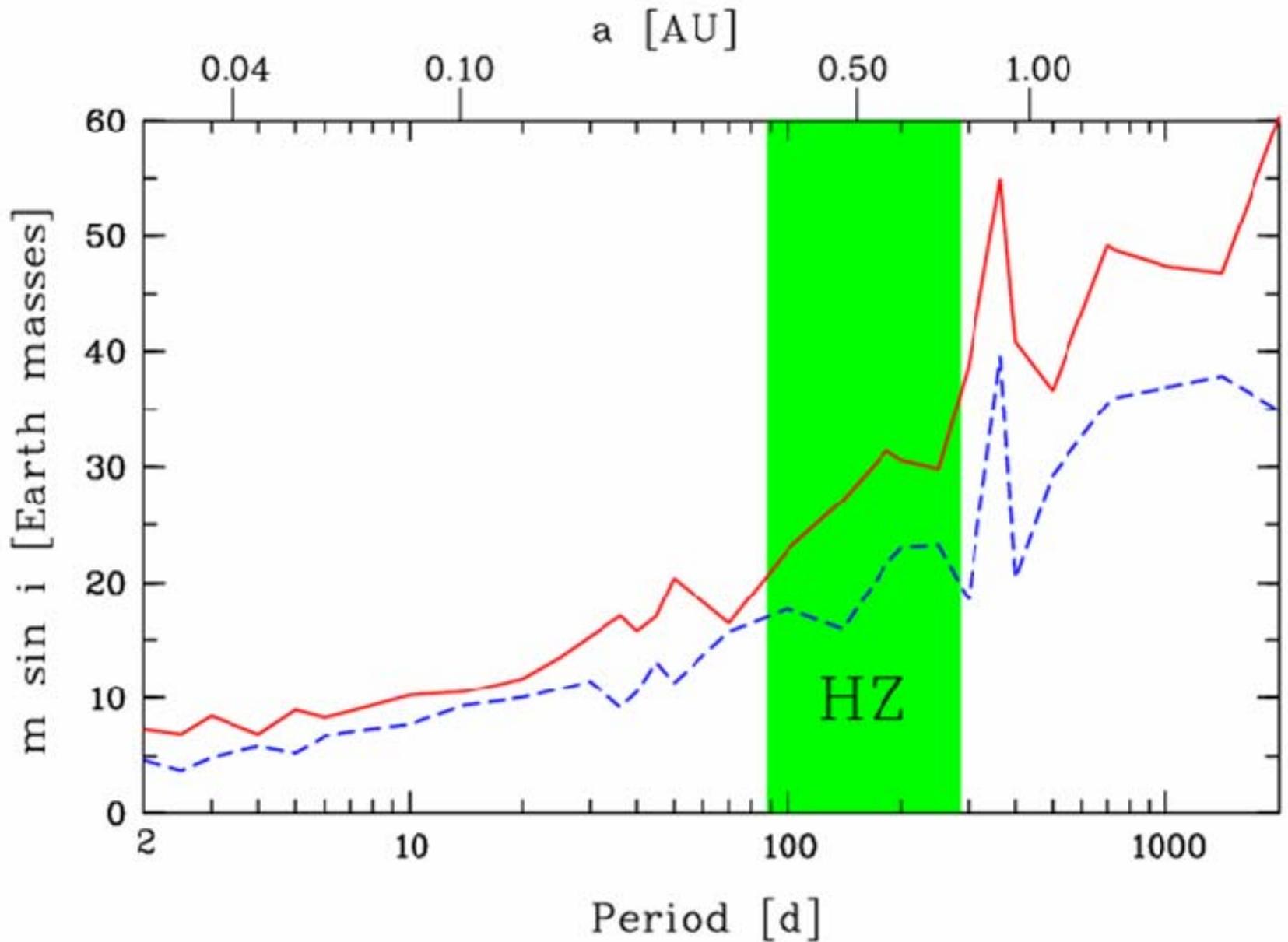
Barnard's star ($M = 0.16 M_{\text{SUN}}$)



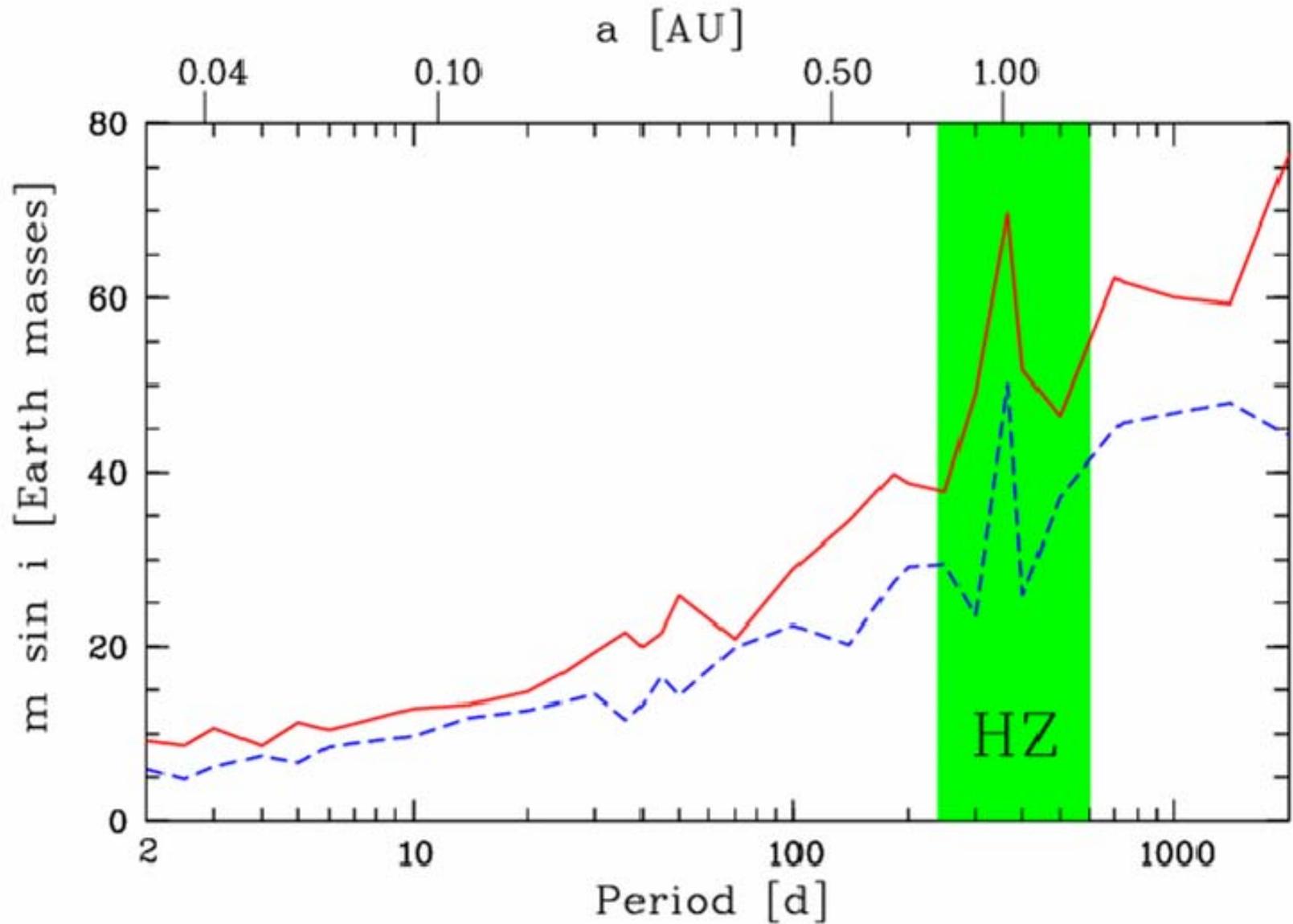
Proxima Centauri ($M = 0.12 M_{\text{SUN}}$)



Prox Cen as a K-dwarf ($M = 0.70 M_{\text{SUN}}$):



Prox Cen as a G-dwarf ($M = 1.0 M_{\text{SUN}}$):



Summary:

Current sensitivity for low mass planets inside the habitable zone (HZ):

Barnard's star: $m \sin i \geq 3 - 5 M_{\text{Earth}}$

Proxima Cen: $m \sin i \geq 2 - 3 M_{\text{Earth}}$

sensitivity cannot be matched for the HZ for earlier spectral types

BUT: minimum masses only!

Outlook:

How do we push toward
 $m \sin i < 1 M_{\text{Earth}}$?

Ideal instrument to perform an
RV survey for terrestrial planets is a
cross-dispersed near IR spectrograph
with high precision RV capability

Of the 158 nearest stars $< 7 \text{ pc}$,
53 have an estimated $M < 0.2 M_{\text{Sun}}$
(RECONS)

....possibly extend search to BDs.

